THE RING AIRFOIL PROJECTILE (RAP)

A LESS-THAN-LETHAL CONFIGURATION FOR THE DELIVERY OF SELECTED CHEMICAL AGENTS

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ABSTRACT

The Ring Airfoil Projectile (RAP): A Less-Than-Lethal Configuration for the Delivery of Selected Chemical Agents

This paper provides the background and current history of the Ring Airfoil Projectile (RAP) in its journey from a proposed shoulder-fired fragmentation grenade having approximately three (3) times the range of the standard 40 mm grenade, through its Type Classification (1978) by the U.S. Army as a Riot Control Projectiles M742, M743 to be launched by a blank cartridge (M755) from a special adapter (M234) mounted on the Army M16A1 rifle.

Although the Army produced approximately 500,000 M742's and well over 12,000 launcher adapters (M234) for the M16A1 rifle, apparently no systems were furnished at that time to the Military Police or National Guard. Later, the Army decided to obsolete their Civil Disturbance Control System based on the Ring Airfoil Projectiles (M742, M743).

About the same time (1997), the National Institute of Justice (NIJ) initiated support for an R&D project using the RAP's non-lethal impact characteristics. In effect, to provide the law enforcement community with a simple, independent launcher that can be readily used to propel a rubber-like Ring Airfoil Projectile (RAP) carrying a limited amount of selected chemical agent and to be effective, but non-lethal, at ranges from point-blank to beyond 40 meters.

The focus of this paper is to describe the performance characteristics of the RAP. Not only its combined kinetic energy and chemical agent dissemination that it can deliver, but also the low aerodynamic drag that enables the projectile to have short time of flight to target, thus increasing the hit probability.

INTRODUCTION AND BACKGROUND

The Ring Airfoil Projectile (RAP) configuration was initially proposed to the US Army as a lethal, high explosive, fragmentation munitions having approximately three (3) times the range of the standard shoulder-fired 40 mm grenade. The tragedy at Kent State (1970) shifted the technology focus to developing a ring airfoil configuration that would be non-lethal and accurate from muzzle (point blank range) to approximately 50 meters range. It is the intention of the author to describe the concept, the associated hardware components and the functional and performance characteristics of the projectile and the newly designed independent launcher.

The first Ring Airfoil Projectile system was designed for launching the RAP from the Army's M16 rifle through use of an adapter fitted to the end of the barrel (or muzzle). The launch is accomplished by using a blank cartridge (M755), which contains a small amount of propellant, sufficient to produce a muzzle velocity of approximately 200 ft/sec and 500 rev/min.

In 1997, the projectile was renamed the RAP, for Ring Airfoil Projectile, in as much as in its non-lethal role, the item is an inert projectile carrying a limited amount of chemical agent. Hence, it is NOT a Ring Airfoil Grenade (RAG). The RAG acronym is most applicable to the original high explosive fragmentation grenade.

GENERAL CONCEPT

The initial concept for applying the extended range, flat-trajectory potential of the Ring Airfoil Projectile was as a shoulder-fired high explosive fragmentation grenade for particular application to the jungle areas, since the flat trajectory could reduce or eliminate the jungle canopy interference. How ever, the state-of-the-art at that time (1970-73) in fuzing precluded the capability for an electronic fuze that could be both time and range sensitive.

In May 1970, the tragic shootings at Kent State led to increased interest in non-lethal weapons concepts or at least less-than-lethal weapon systems that could be controlled.

The Ring Airfoil Projectile (RAP) not only could provide a less-than-lethal kinetic energy projectile, but the projectile could also contain a chemical agent which could be dispersed at target impact.

THE KEY CONCEPT FOR LESS-THAN-LETHAL

If the Ring Airfoil Projectile (RAP) could be designed to be less-than-lethal at point blank (or muzzle) impact, then, as the RAP flew downrange, it would be losing energy as its velocity decayed. Hence, the entire trajectory of the RAP would be "less-than-lethal." Further, the lift force generated by the airfoil cross-section produces a non-ballistic, relatively flat trajectory. This is confirmed by both analytical and experimental data. Figure 12 compares the trajectory profiles for a variety of systems.

An extensive series of biophysics (wound ballistics) tests provided the launch parameters for the selected RAP size. Thus, for an approximately 2.5" diameter and chord of 1.35", with a flight weight of about 33 grams, the selected muzzle velocity was 200 ft/sec. The maximum velocity at which mixed results (serious injury) occurred was 215-220 ft/sec.

Hence, by launching the RAP at a nominal muzzle velocity of 200 ft/sec, a safety margin of 15 to 20 ft/sec results. Another view of this is that if some additional impact energy is required, the launch velocity may be increased 15-20 ft/sec without making the RAP a lethal system.

BRIEF DESCRIPTION AND DISCUSSION FO THE RAP'S AEROBALLISTIC THEORY

Basically, a ring airfoil is formed when a conventional wing is rolled into a ring (see Figure 1). By controlling the ring airfoil's center of gravity (c.g.) location relative to the center of pressure (c.p.) and imparting spin to the ring airfoil as it is launched, a relatively flat and stable trajectory results. In contrast to the conventional projectile, which flies a ballistic trajectory, the RAP flies a relatively flat trajectory while being launched at a significantly lower elevation angle than the ballistic projectile. (Figure 2).

A basic description of the trajectory is as follows: The RAP's relatively flat trajectory is a result of a near coincidence of the c.g. and c.p. together with the spin, providing a gyroscopic effect on the attitude (angle) of the RAP. As gravity pulls the ring downward following launch, an angle of attack is generated between the axes of spin and the flight path. The gradually increasing angle of attack results in the generation of lift by the ring airfoil, which partly offsets the normal gravity drop. This lift force combined with the Ring's low aerodynamic drag shaping produces a relatively flat trajectory.

This result has been confirmed by experimental test firings. For example, in comparing a RAP with a 40 mm grenade of similar mass, launched at the same muzzle velocity, the RAP achieved nearly three (3) times the maximum range of the 40 mm at less than one-third (1/3) the elevation angle of the 40 mm.

The RAP

It is the Ring Airfoil Projectile that forms the basis of this less-than-lethal weapon system. The external dimensions (2.5" diameter in length, or chordal measurement of 1.35"" are such that the shape is sufficiently large to minimize eye-damage. Weighing just over 1 ounce (~33 grams), the projectile body is made of relatively soft rubber with eighteen (18) compartments or cavities located circumferentially (Figure 8). The presence of the cavities allows the target impact energy to be released over a greater skin area and a longer time interval, reducing the level of peak impacts, thus minimizing the possibility of serious injury from any blunt trauma due to the RAP's impact condition. The cavities may be filled with a selected riot control agent. Originally, the chemical was CS powder. Currently, OC is being considered.

The use of a launcher adapter on the M16A1 rifle is a somewhat inefficient means to propel the RAP. By comparison, the new launcher design is a more compact unit. It is essentially a self-contained device. That is, the shorter barrel contains a pre-loaded saboted RAP and a primer to ignite the propellant. Once the barrel is placed in the pistol frame containing the trigger mechanism, the device is ready to be fired. After firing, the barrel can be ejected and a "fresh" barrel can be inserted in the frame.

It appears feasible to design and develop a multi-shot design that can fire three (3) successive RAP's and then be quickly reloaded.

COMMENTS

Last year (1999) the National Institute of Justice, in describing its Less-Than-Lethal Technology Program, categorized the Ring Airfoil Projectile (RAP) as a "blunt impact projectile."

This is only partially correct. The RAP is a combined carrier-delivery device that depends on kinetic energy and centrifugal force transferred by target (blunt) impact to disperse a limited quantity of chemical (incapacitating) agent on and around the target.

The RAP has never been intended as a "knock-down" weapon. Rather, it can produce a sharp "sting" similar to being hit by a fastball pitch. However, the "sting" is then almost simultaneously followed up by the delivery of an approximately three-foot diameter cloud of an incapacitating riot control agent.

The RAP deserves reinvention. In the (interim) period; i.e., from the US Army's Type Classification of the original system in May 1978 until the fall of 1997, when NIJ commenced funding support for the development of an independent RAP system, the RAP has not lost any of its (potential) performance characteristics, particularly being non-lethal at point blank range.

Nor have any "new" projectiles been developed which can claim non-lethality at point blank range as well as being able to deliver a chemical payload from point blank to approximately 50 meters range.

BRIEF HISTORY (UNOFFICIAL/INCOMPLETE)

1969--Initial experiments launching ring airfoils with spinning barrel air gun. Various concepts.

1970 (May)--Kent State University incident: 4 deaths, 9 wounded.
--Suggested concept rubber-type ring airfoil as anti-riot, low-lethality projectile.

1973-1978--R&D Civil Disturbance Control System.

1978-1987--Production of M234 Launcher Adapter, M743 (STING RAG), M755 Blank Cartridge.

1987--"Report on the Attorney General's Conference on Less-Than-Lethal Weapons, Sweetman, S., National Institute of Justice, Washington, DC.

1995--System declared obsolete and placed in the Army Arsenal's demilitarization account. Classified obsolete because of the change from the M16A1 to the M16A2. The system was not demilitarized because of lack of funding.

19976(June)--Chance meeting with military technical liaison at annual TECOM Technical Review at Johns Hopkins Applied Physics Lab.

1996(Dec.)--Military technical liaison obtained several units of the US Army Civil Disturbance Control System.

1997(Jan)--Test firings of system by Los Angeles Sheriffs Department. Successful unofficial Demonstration.

1997(Feb)--Unofficial test firings and briefings to Regional Advisory Council for the National Law Enforcement and Corrections Technology Center-Western Region.

1997(March)--Three presentations to various NIJ committees.

1997(July)--Proposal submitted to NIJ.

1997(Sept)--Funding support by NIJ.

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